Renewable Energy & Efficiency Modeling Analysis Partnership (REMAP): Status

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REMAP Overview: Focus and Process

- **Overall**: To understand how and why different energy models give similar and/or different answers in response to a set of focused energy-related questions. Focus on understanding reasons for model differences, not on policy

- **Focus:** REMAP analysis will focus on understanding high Renewable Energy penetration scenarios over medium timeframe (out to 2025)

- **Overall Process**

  - Decided on topic for first REMAP: RE penetration scenarios in 2025

  - First meeting of modelers and analysts to discuss models, refine topics and provide guidance for base case runs

  - Modelers carry out Base Case runs: Reference, 10% and 20% penetration under native model assumptions ⟵ **Where we are**

  - Guidance for Tier 1 runs to align models to common assumptions – where possible

  - Review of Base Case and Tier 1 results – Present and/or publish insights

Received a good response for base case runs

- Models/Modelers reporting for Round 1:
  - **IPM** (Leiberman, EPA/ICF)
  - **HAIKU** (Evans/Palmer, RFF)
  - **NEMS** (Namovicz/Smith , EIA)
  - **NEMS-GPRA** (Leifman (DOE)/Wood (OnLocation))
  - **WinDS** (Short/Blair, NREL)
  - **SEDS** (Short/Ferguson, NREL)
  - **Top-D, Bottom U CGE** (Sue Wing, Boston U)
  - **NE-MARKAL** (Wright/Goldstein) IRG/NESCAUM)

- There are 4 or 5 other participating models that have not reported yet, but anticipate doing the base case and tier 1 runs together

- This is a largely voluntary effort, and so many modelers have to fit this analysis between their existing commitments

Attempts were made in the base cases for some degree of consistency

- ## **Base case: Reference case**
  - Allow models to use "native" assumptions
  - Assume "current-laws", including sunsets where applicable
  - Different models may employ different assumptions for current laws

- ## We recommend <u>consistency</u> in the following areas
  - Federal PTC duration – available for eligible projects built in 2007 and earlier; No PTC thereafter
  - Federal ITC duration – 30% ITC for commercial and residential ($2000 cap for residential); 10% ITC commercial after 2007
  - Accelerated Depreciation – 5-year MACRS for eligible technologies

- ## We recommend <u>clarity</u> for (modelers should describe treatment of)
  - Existing State RPS policies
  - State/regional carbon policies
  - State public benefits funds for renewable energy
  - State tax incentives for renewable energy
  - Utility regulation (cost-of-services vs. market-clearing pricing)
  - Federal air quality regulations

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Attempts were made in the base cases for some degree of consistency (continued)

- **Base Case: 20% and 10% national renewable energy target by 2025**
    - 3% in 2008, increasing by 1% each year to reach 20% by 2025
    - 3% in 2008, increasing by .412% each year to reach 10% by 2025

- Achieved nationally through mandatory renewable energy target on all sales in the U.S., with national trade in RECs

- Existing and new non-hydropower renewable resources
    - Modelers should describe which specific RE techs/fuels are modeled
    - Both sides of customer meter
    - Includes renewables fraction of biomass co-firing

- Hydro and MSW are not eligible for renewable energy target

- No multipliers, set asides/tiers, cost caps, load exemptions

- No sunset - 20% must continue to be achieved after 2025

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For Base Case all models reported 3 runs: Reference Case, 10% and 20% penetration results for 2025

- For both conventional and renewable technologies all models reported:
  - Generation – used to define penetration
  - Capacity
  - Carbon Emissions
- Most models also reported electricity prices (and generation costs)

- A number of models reported some regional results
  - WinDS, ICF, NEMS-EIA, NEMS-GPRA, NE-MARKAL
- Only 3 models reported macroeconomic outputs, such as GDP
  - NEMS-EIA (full list of outputs), NEMS-OnLocation (limited), Top-Down/Bottom-Up
- One model is stochastic (SEDS)

  Over the next few slides we will look at some of the preliminary results. Sometimes there are significant differences. Some of these differences are structural, others reflect different assumptions. Results are partially disguised. Tier 1 runs should help resolve some of these differences.

The 20 percent penetration case for 2025 broadly corresponds to 900 - 1,200 TWhs – though the RE technology split varies markedly by model

2025 Renewable Generation – 20% Penetration
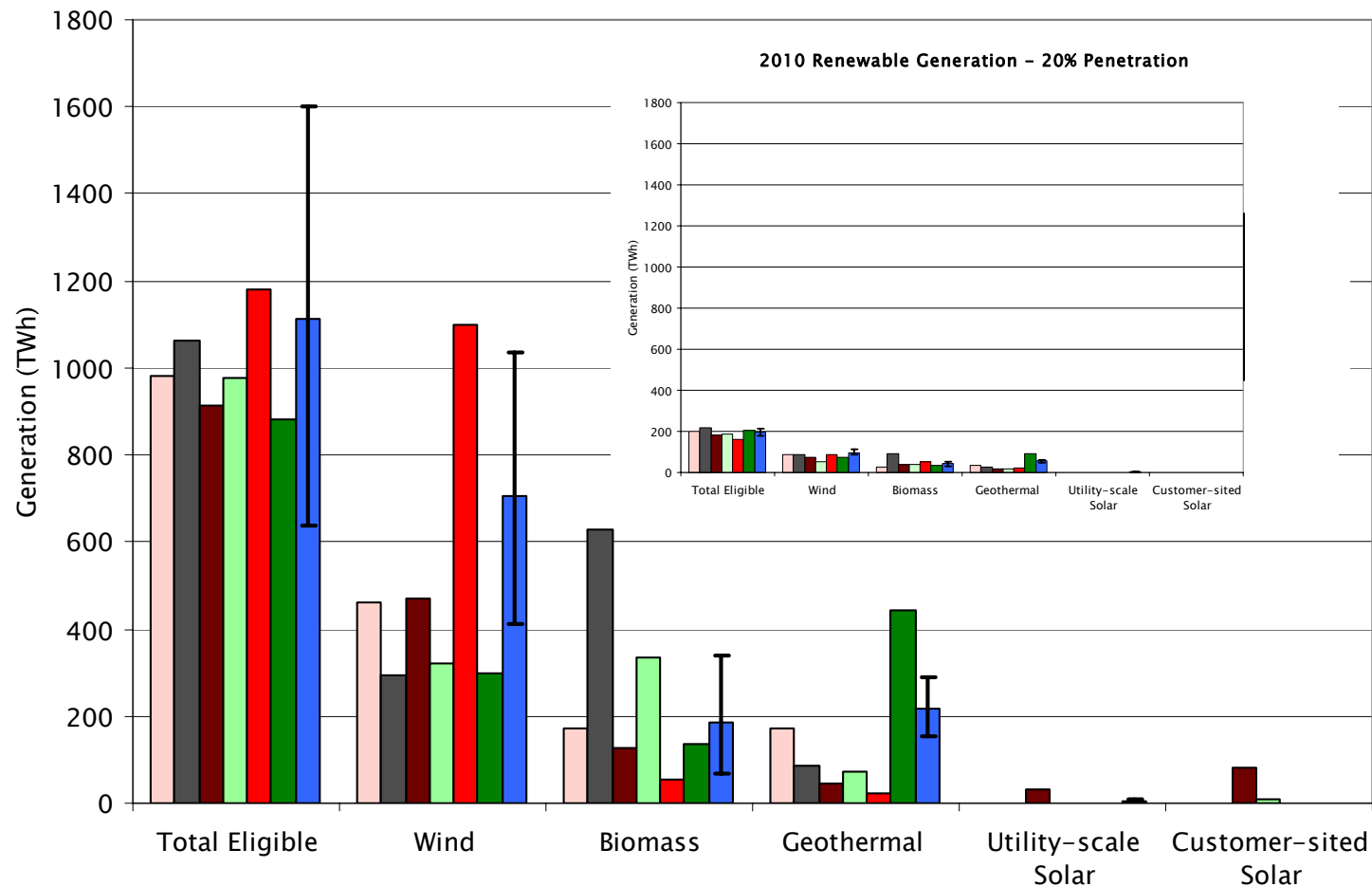
Preliminary Results – Subject to Revision - DRAFT

The capacity differences are even greater because of differences in utilization for different RE technologies – Some of these differences are model driven, while others may be due to differences in assumptions
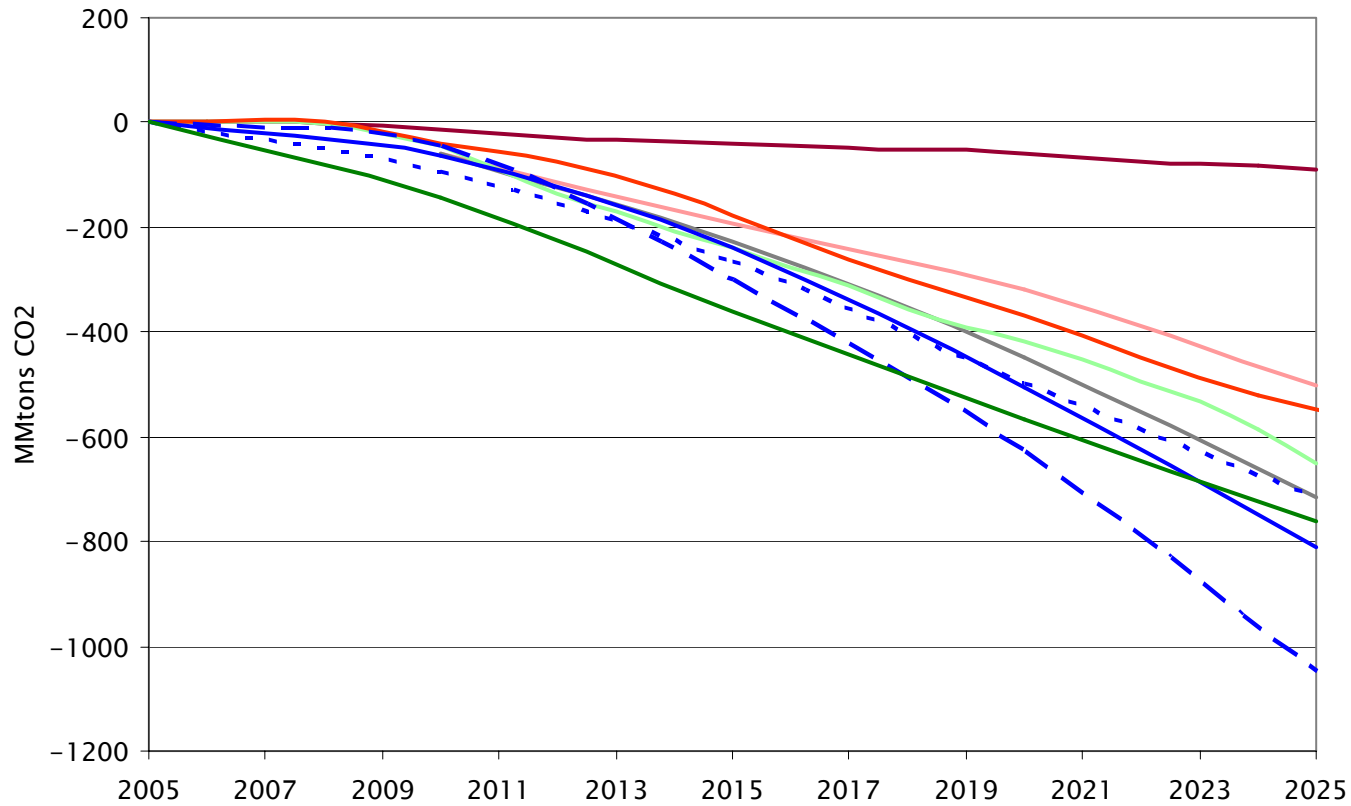
2025 Renewable Capacity – 20% Penetration

Preliminary Results – Subject to Revision - DRAFT
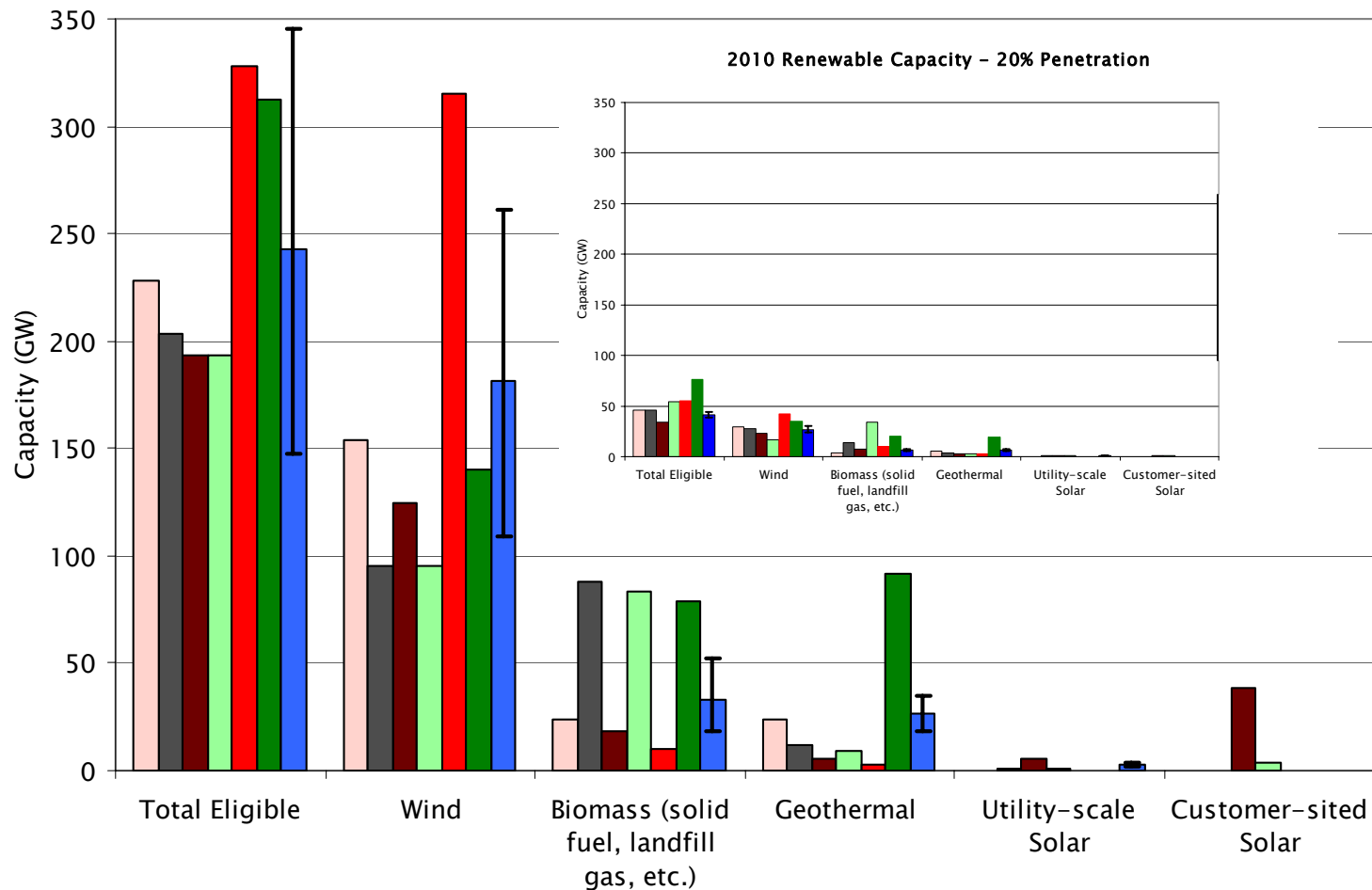
Carbon emission reductions at 20% penetration varied widely by model

Change in CO2 Emissions with 20% Penetration

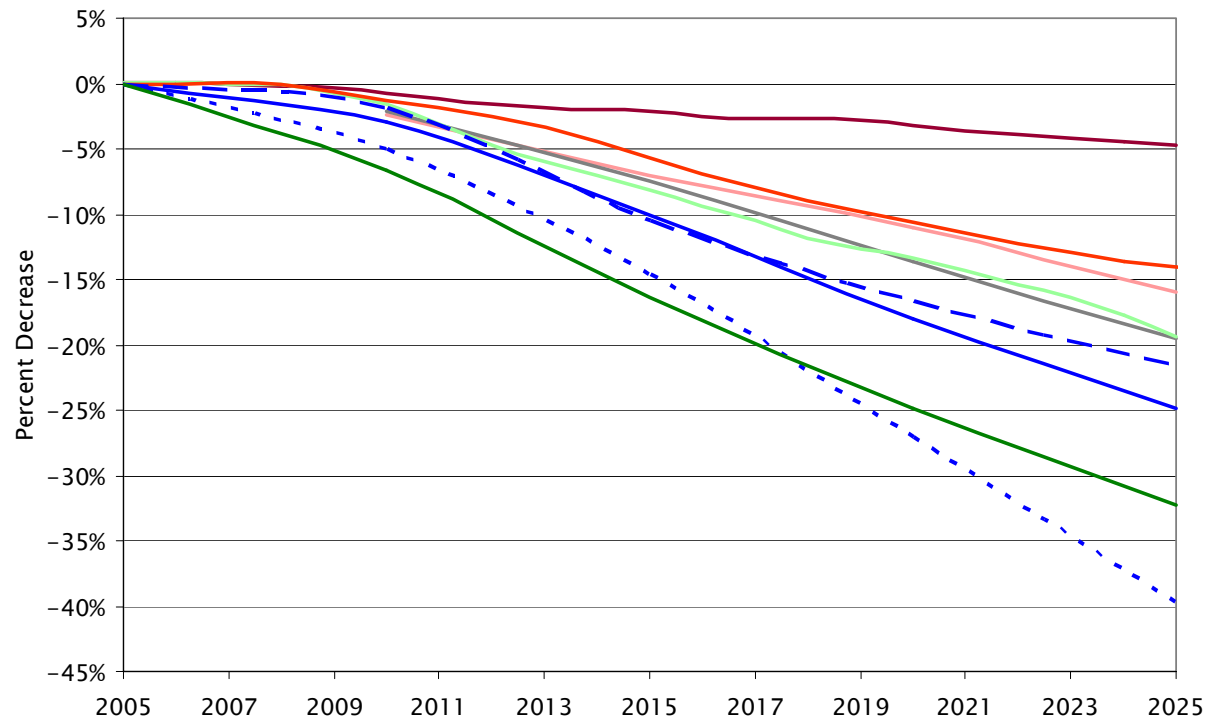**Preliminary Results – Subject to Revision - DRAFT**

# Total carbon savings relative to model baselines vary widely

Percent Change in CO2 Emissions with 20% Penetration

Preliminary Results – Subject to Revision - DRAFT

Electricity prices are seen to fall in the future. The cost of renewable energy is seen in most but not all models in terms of relatively higher prices

Retail Price of Electricity

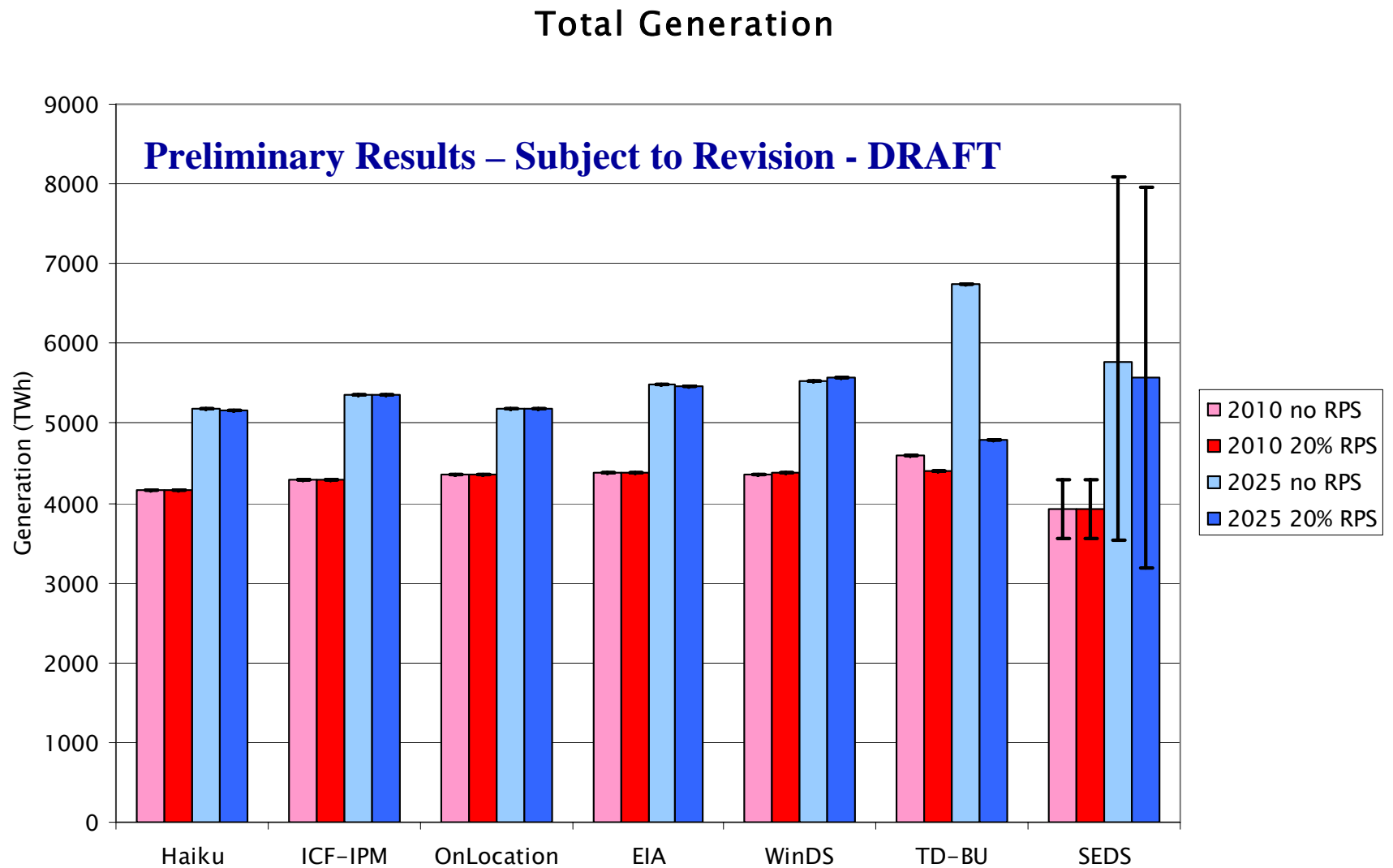Preliminary Results – Subject to Revision - DRAFT
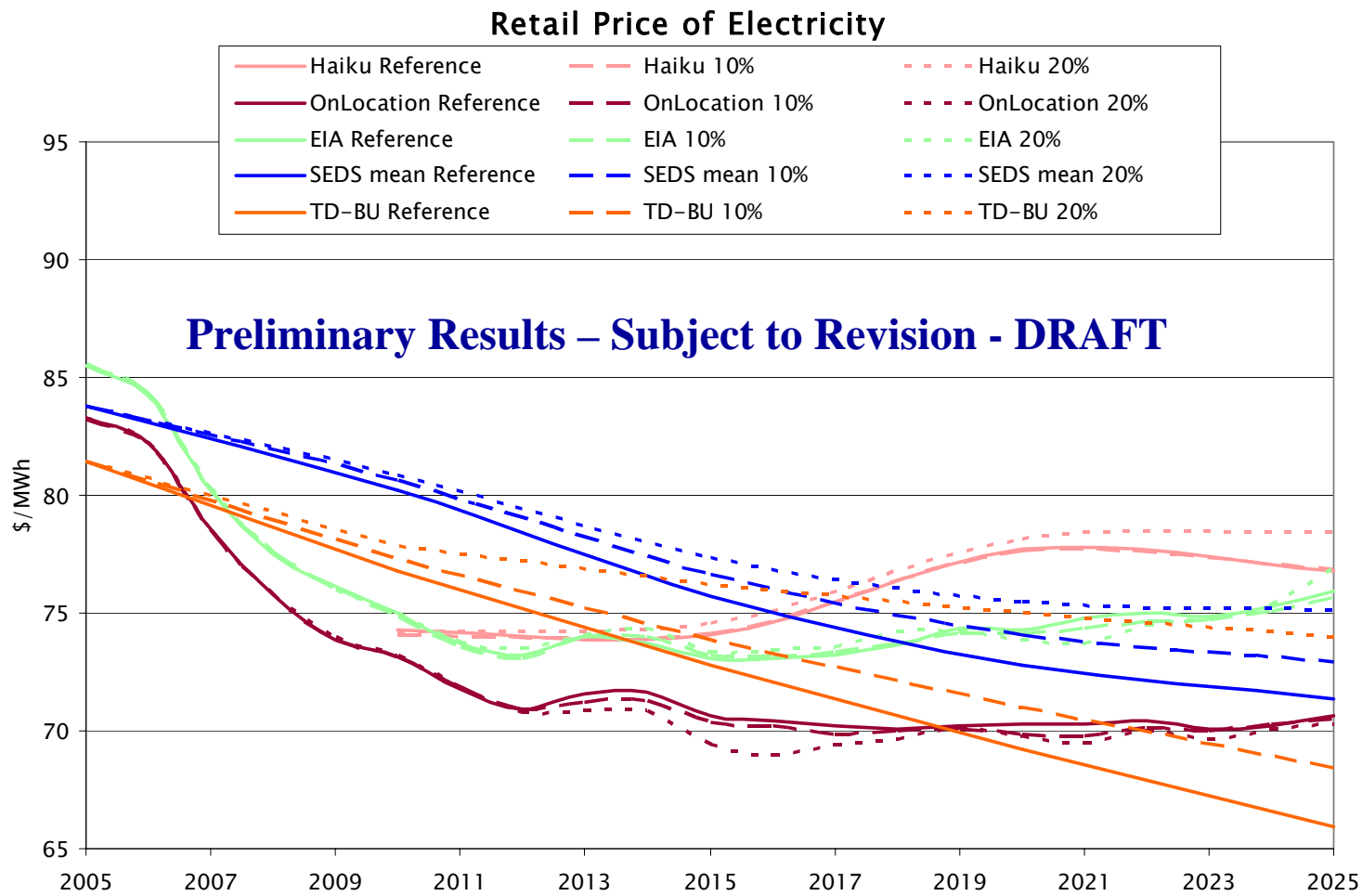
There are many factors behind the observed differences some reflect structural differences, others reflect different assumptions

- Some observed differences are because some models bias some Renewable Energy technologies over other RE technologies
  - This can be important to the results e.g. Biomass may have a very different utilization and carbon footprint than wind say.

- Some models may assume different demand (and hence generation needs) over time

- Reference cases characterization for RE and conventional technologies may be very different (e.g. capital costs over time, learning curves, carbon emissions)

- Differences in treatment (or lack of treatment) of regional differences to generate US-wide results

Tier 1 Runs will hopefully provide a better understanding between those differences due to structural differences and those differences due to assumptions - In this way the "value" of models results – alone and in aggregate - will be better understood

One factor behind differences is that different models differ in total generation needed in 2025

Total Generation

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Chart legend:
- 2010 no RPS
- 2010 20% RPS
- 2025 no RPS
- 2025 20% RPS

Y-axis: Generation (TWh), scale 0 to 9000

X-axis categories: Haiku, ICF–IPM, OnLocation, EIA, WinDS, TD–BU, SEDS

Differences in References Cases: Capacity differences – partly reflecting limitations of some models to model certain technologies
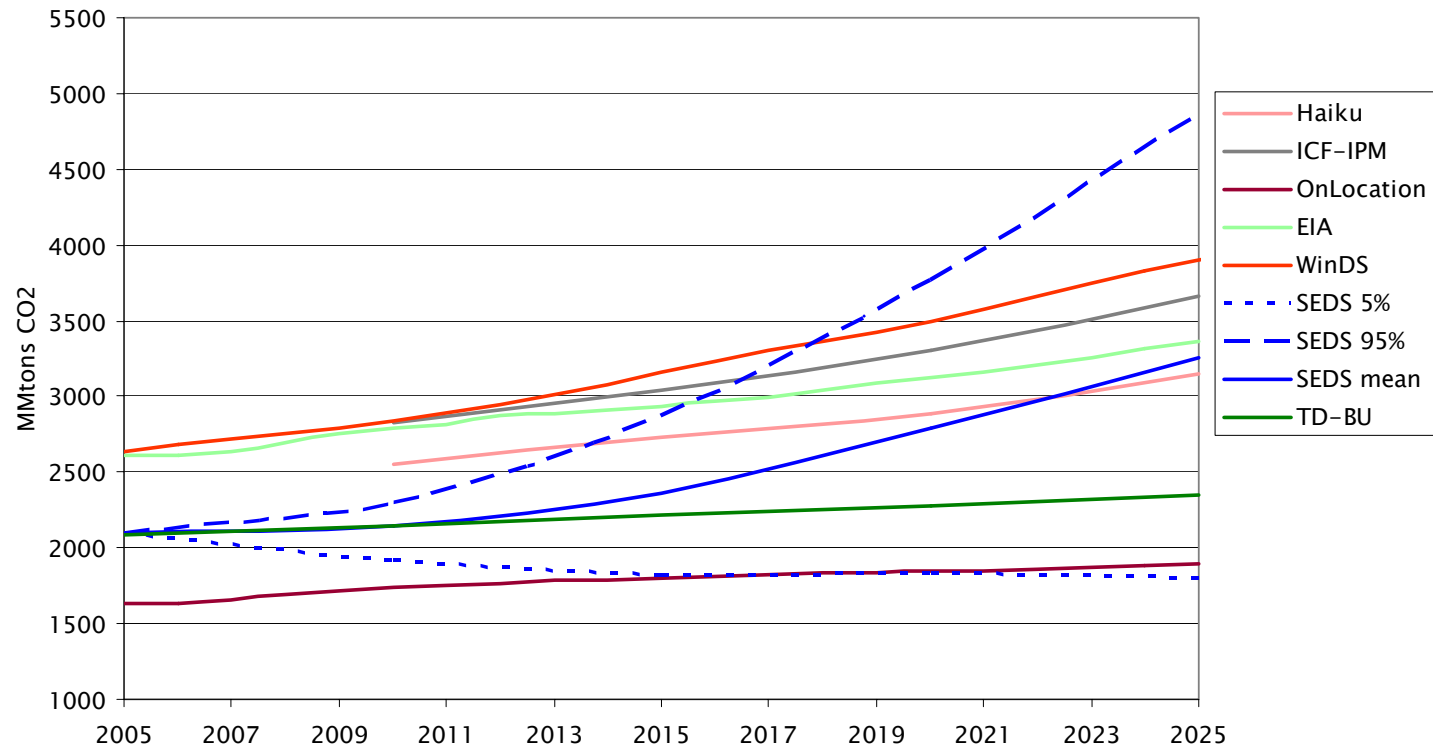

2025 Renewable Capacity – Reference
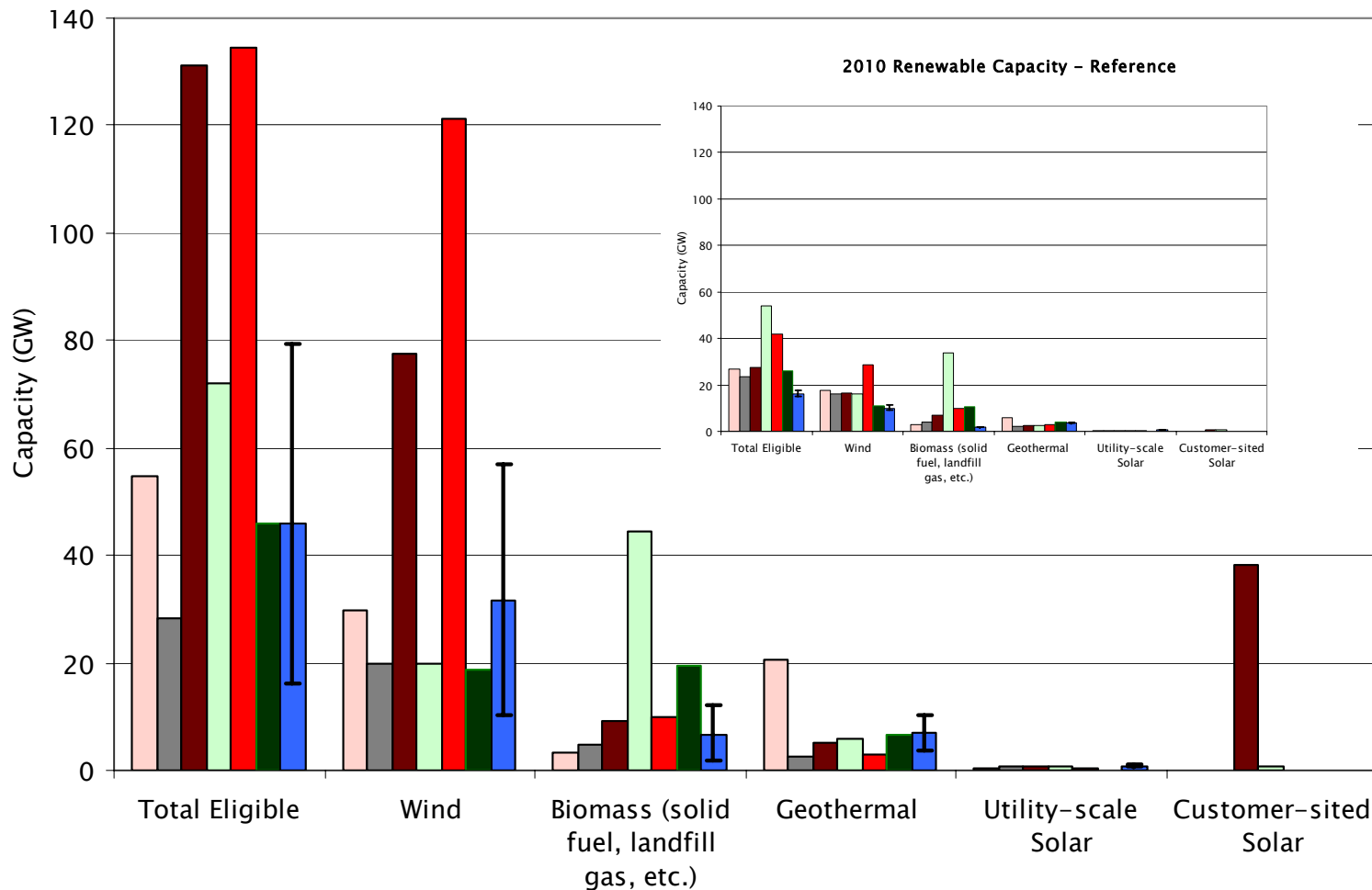
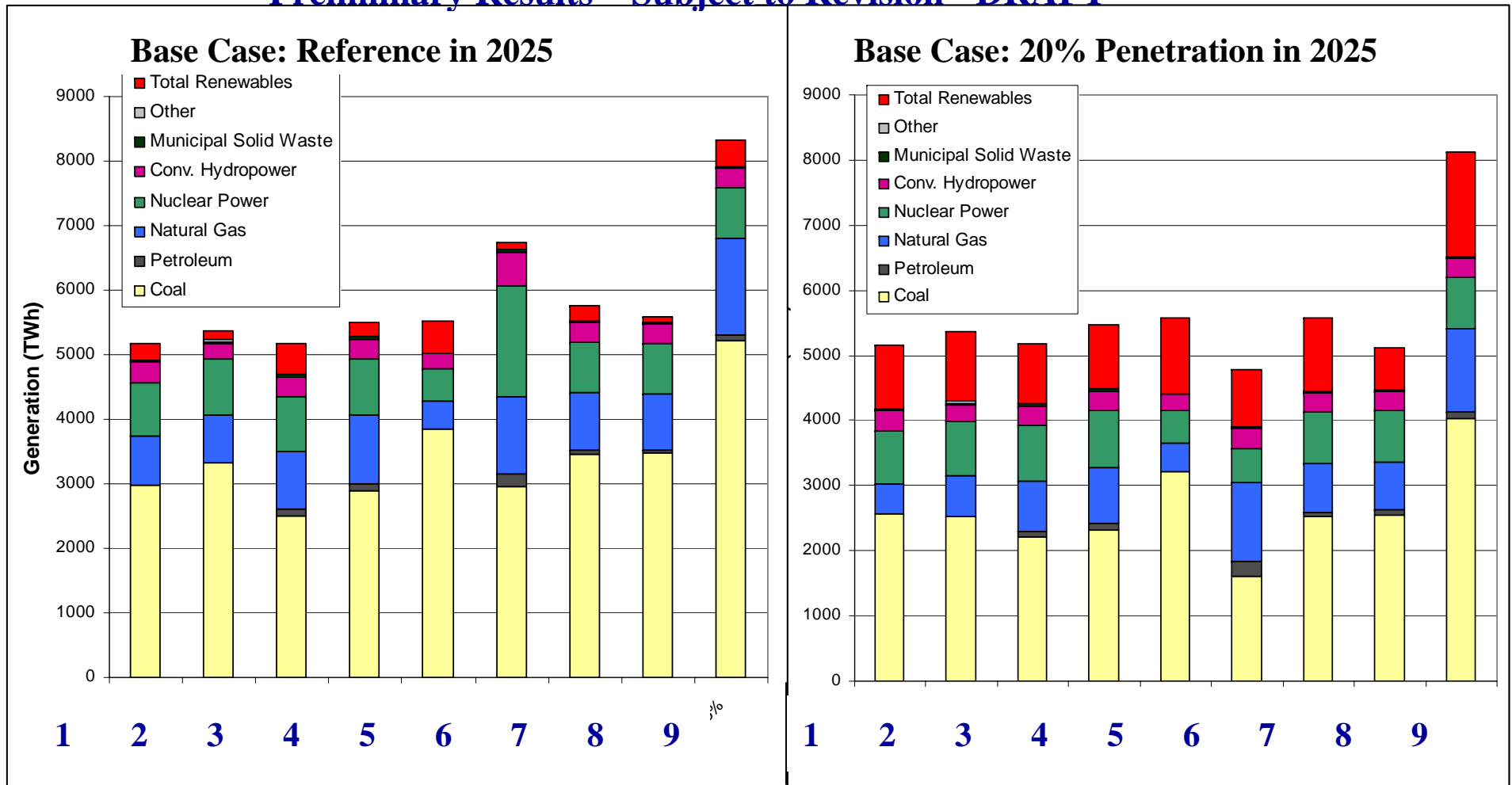# Differences in References Cases: Carbon Emissions vary significantly by model

Reference Case CO2 Emissions

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Generation mix of conventional and renewable energy varies markedly. This will impact prices and carbon emissions

Models (1 through 9)

The next step: "Tier 1" runs should allow a better understanding of what differences are structural vs. based on assumptions

- Despite some alignment the differences shown by models in results in base case runs for new RE capacity to meet 20% target, and overall changes in carbon emissions are significant and need to be better understood

- The purpose of upcoming "Tier 1" runs is to improve the calibration of input assumptions wherever possible to better reveal the source of differences in model results (structural vs. assumptions)

  - **Improved understanding of model results:** Tier 1 runs should provide a better sense of the value or "confidence" in results of specific models, and models generally.

  - **Tier 1 alignment includes**:   *Some potential issues*

    - Fuel   Derived vs. external

    - Technology costs and cost reductions   Learning curve issues

    - Load growth   Modeling economy assumptions and feedback

    - Resource base   Availability and supply curves

The next step: "Tier 1" runs should allow a better understanding of what differences are structural vs. based on assumptions (Cont.d)

- Guidance is being developed for Tier 1 runs.

- Improved alignment is non-trivial in some instances because of fundamental differences in how the different models work e.g.

  - All models generate electricity prices using fuel costs that are either generated internally in the model, or accepted externally

  - External gas prices for Tier 1 will be provided from results of a supply-demand equilibrium model run at 20% penetration; previously such models may have used AEO reference case for natural gas prices for all scenarios.

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